PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

ELASTICITY

Example

1. A wire of length 3m and stretched by hanging a weitght of 2kg from it and the elongtion is 2mm.

Calculate the Yong's modulus and the strain potential energy of the wire.

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2. A steel wire 2mm in diameteris ust streched between two dixed point at a temperature of $20^\circ C$. Determine its tension when its temperature falls to $10^\circ C$. Linear expansivity of steel $= 11 \times 10^{-6} / K, Young \bmod \underline{u}s$=2 xx 10^(11)//m^(-2)`

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3. Find the formula for the work done is stretching a wire and apply it to find the elastic energy stored in a wire originally 5metre long and 1mm in diameter, which is streched by 0.3mm due to a koad of 10kg. Aksi calculate the Yongs's modulus of the wier.

$= g = 9.8ms^{-2}$

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4. When a rubber cord is streched, the changed in volume in neglible compared to the change in its linear dimension. Then Posisson's ratio for rubber is

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5. A load of 7.6kg hangs from the lower end of a stell wire is reigly clamped at the upper end. When the load immersed in wate, the length of the wire changes by 1mm. Calculate the length of the wire.. (Young's moduls of steel =$2ss10^{11}Nm^{-2}$ diameter of the wire -0.4mm density if neterual of material of load =$7600kgm^{-3}$ and $g = 9.8ms^{-2}$.

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6. A steel wire of length 1m and diameter 4mm is stretched horizontally between two rigit supports attached to its end. What load would be required to be hung from the mid-point of the wire to produce a depression of 1cm? $(Y = 2 \times 10^{11} Nm^{-2})$

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7. A steel sprial spring has on unstreched length of 8cm and when a mass is hung o it, its length becomes 10cm. Calculate the periodic time of the oscillation that would occur if the masss were displaced vertically.

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8. Find the increment in the length of a steel wire of length $5m$ and radius $6mm$ under its own weight. Density of steel $= 8000kg/m^3$ and young's modulus of steel $= 2 \times 10^{11} N/m^2$. What is the energy stored in the wire ? (Take g $= 9.8m/s^2$)

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9. A uniform elastic plank moves due to a constant force F_0 applied at one end whose area is S. The Young's modulus of the plank is Y. The strain produced in the direction of force is

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Exercies A

1. A copper wire 2 m long and 0.5m in diameter supports a mass of 10kg It is stretched by 2.38 mm . Calculate the Young's modulus of the wire.

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2. Calculate the strain potential energy of a horizontal rod 1 m long and $0.4 \times 10^{-4} M^2$ in cross - section fixed at both ends , which is cooled from 25° c to 10° C Linear expansivity of the material of the rod $= 11 \times 10^{-6} / K$ and Young's modulus $= 2.1 \times 10^{11} Nm^{-2}$

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3. A wire of length $3m$ diameter $0.4mm$ and young's modulus $8 \times 10^{10} N / m^2$ is suspended from a point and supports a heavy cylinder of volume $10^{-3} m^3$ at its lower end . Find the decrease in length when the metal cylinder is immersed in a liquid of density $800 kg / m^3$.

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4. The wire of a Young's modules appartus is elongated by 2 mm when a brick is suspended from .it When the brick is immersed in water the wire contracts by 0.6mm Calculate the density of the brick given that the density of water is $1000kgm^{-3}$

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5. A bar of heated to a tempature of 500°C Its ends are are then clamped at two points 1 m apart and it is allowed to cool .Find the temperate at which at which it will break ,assuming linear expensivity of steel $= 11 \times 10^{-6}) / K$, Young's modulus of steel

$= 2 \times 10^{11} Nm^{-2}$ and braking stress for steel $= 8 \times 10^8 Nm^{-2}$

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6. Find the greatest length of steel wire that can hang vertically without breaking.Breaking stress of steel $= 8.0 \times 10^8 N / m^2$. Density of steel $= 8.0 \times 10^3 kg / m^3$. Take $g = 10m / s^2$.

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7. What work has to be done to make a hoop out of a copper band of length $l = 3m$, width h=6 cm and thickness $\delta = 1mm?$ (Y of copper $= 1.3 \times 10^{11} Nm^{-2}$)

[Hint: Consider strain energy in a a thin layer and intergraate from $r - \delta/2 \text{to} r + \delta/2$]

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8. A wire of length 2 ,m and radius 2 mm is stretched by 2.5 mm when a load of 5 kg is suspended from it Another wire of the same material put of length 1 m and radius 1 mm is attached below the load and a load of 3kg is suspended from this wire what is the total increase in length and what are the individual exensions of the wirs ?

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9. A wire of length 1 m and radius 1 mm is welded to another wire of length 2 m and radius 2 mm the free end of the first is clamped and aload of 5kg isplied at the free end of the second wire . What is the total increase of the compound wire ? (Y of both wires $= 2 \times 10^{11} Nm^{-2}$)

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10. A unifrom pressure P is exerted P is exerted on all sides of a solid cube at temperature be raised in order to bring cubic volume back to what it had been before the pressure was applied (Xcubicacl expansivity of the material of the cude $= \alpha$ and the bulk modulus of elasticity is β)

$$\left[\text{Hint}: \frac{P}{\frac{\text{change in volume}}{\text{original}}} V_t = V_0(1 + \alpha t)\right]$$

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11. Two springs have force constants K_1 and K_2, where $K_1 > K_2$. On which spring, more work is downe if

(i) they are stretched by the same force?

(ii) they are stretched by the same amount?

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Exercies B

1. A steel wire og lrngth 1 m and diameter 3 mm is stetched horizontally between supports attached at its ends .What load would be required to be hung from the mid -point of the wrie would be required to produeced a depression of 1 cm?

$(y = 2 \times 10^{11} NM^{-2}, g = 9.8 ms^{2})$

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2. Alight rod of length 2 m is suspended horizontlly from the ceiling bty means of two vertical wirs of equal length tied to its ends One wire is mode of steel and is of cross - section 0.1 sq cm and the other is of brass of cross -section 0.2 sq cm Find the postion along the rod at which a wight may be hung to produce (i) equal stress in both wirs (ii) equal strain in both wires (Y for brass $= 10 \times 10^{10} Nm^{-2}$ and $Y$for steel $= 20 \times 10^{10} Nm^{-2}$)

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3. A 4-kg block extends a spring by 16 cm from its unstretched postion .The block is removed and a 0.5 - kg boby is hung from the same spring If the spring is then stretched and released , what is the time period of oscillations of the mass suspendrd ? What is the force constant of the spring ?

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4. A unfrom spring whose unstetched length is/ has a force constant K.The spring is interger .What are the force constants K_1 and K_2 of the two peces in terms of n and K?

[Hint :force constant is inversely proportinal tolength.]

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5. A light elastic string is suspended vertically from a point and carries a heavy mass at its lower end , which stetches innature and its time period is equal to that of a simple pendulum of length l.

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6. A ring of lead (relative density =11.3 and breaking stress $\sigma_b = 1.5 \times 10^7 Nm^{-2}$) of radius r=25 cm is rotated about its axis .What is the number of rps at which the ring will rupture?

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7. A reinforced concrete column consists of concrete filled with iron bars. Assume that iron occupies one-twentieth of the total cross-section area and Young's modulus of concrete is one-tenth of that of iron. The concrete column is under a compressive load P. Determine the fraction of load on the concrete.

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8. Two steel plates plates are soldered on two sides of a copper plate .What tensions will arise in the plates if the temperature is increaased by $t^{\circ}C$? All the plates have the same cross- sections the coeffcents of expansion ofcopper and steel are α_c and α_s and thier Young 's modulus . are Y_c and $Y_s$repectively Aera of rach interface +A.

[HInt : The net expansion (thermai + elastic) is the same for the all the plates .THe tensile force on each steel plate is half the tensile force onthe cooper plate.]

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9. What internal pressure (in the absence of an external pressure) can be sustainerd by (a) a glass tube of wall thickness and rediuas $sigmma)(b)$ breacking stress of glass $= 5 \times 10^7$ Pa.

[Hint: outward force due to internal pressure is balanced by the inward elastic foprce .]

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10. An iron ring of radius 50 cm and rhickness 1 cm is heated sufficiently and then put on a wooden carrrrt whell of the same radius at $40^\circ C$ WHAT IS the force per unit area wih which the ring grips over the whell cooled to $27^\circ C$? Toung's modulus of iron

$= 2 \times 10^{11} \ Nm^{-2}$ and liner expansivity of iron $= 11 \times 10^{-6} K^{-1}$ Neglect thermal contraction of the wooden wheel.

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11. three pieces of wire of the same intererinal and radius but of different length are tied to three - colliner , , equispesd pege in the ceiling of a room knotted together at their other ends so that the side wirs subtend the same angle α with the midda one .If a load P is attached to the knot ,calculate the tension in the wires.

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12. A perfectly right and wightless rod of length l is hinged at ine end to a vertical wall and is held horizonatal by two vertical wirs of the same length ,radius and material , which are tied at distance a and b grom the hinged end of the rod .

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13. A light rod is supported horizontally by two wires of the same length L and area of cross -section A but of different moduli of elasticity Y_1 and Y_2 A heavy mass m is suspended at a disance a_1 from the first wire and a_2 from the second wires Find the period of errtical oscillations of the mass.

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14. A cylinder of height H and radius R is filled with a liquid of density p . What is the disrupting stress at a heght h? where is it maximum and where minimum ?

[Hint : Disrupting stress is the elastic force per unit length Consider equilibrium of an element of the wall.]

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